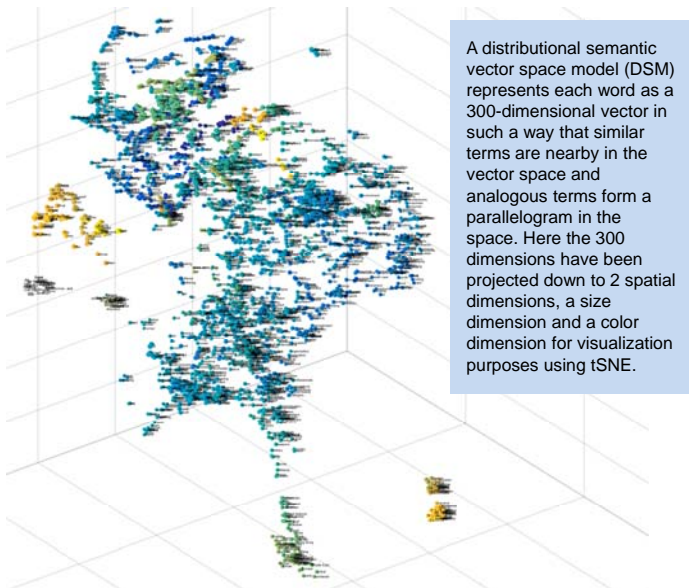# Reasoning Under Uncertainty

S&T Campaign: Information Sciences
System Intelligence and Intelligent Systems

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Objectives

- Military decisions are "wrapped in a fog of uncertainty." Reasoning systems need to be able to give approximate answers when exact answers are impossible.
- Approximate reasoning with partial information
- Expand a knowledge base by exploiting distributional semantics at query time
- Overcome inflexibility and incompleteness of reasoning for autonomous systems

A distributional semantic vector space model (DSM) represents each word as a 300-dimensional vector in such a way that similar terms are nearby in the vector space and analogous terms form a parallelogram in the space. Here the 300 dimensions have been projected down to 2 spatial dimensions, a size dimension and a color dimension for visualization purposes using tSNE.

Challenges

- Analogical reasoning is very difficult with a knowledge base
- Knowledge bases are brittle and incomplete

Approach

- This work builds on recent discoveries allowing for training of DSMs on massive text compora (e.g. word2vec) and decades of work in the development of a fast common sense knowledge base (e.g. researchCyc)
- Those trying to bridge the divide between distributional semantic models and knowledge bases are either pulling information out of the DSM to place in the knowledge base, or using the DSM to find synonyms to terms in the knowledge base. Neither approach takes full advantage of the knowledge contained implicitly in the DSM.

ARL Facilities and Capabilities Available to Support Collaborative Research

- We have measured the accuracy of estimated answers to queries where the knowledge base contains varying amounts of related information and developed a method for estimating the accuracy of answers.
- Summers-Stay, Douglas, C. Voss, T. Cassidy. Using a Distributional Semantic Vector Space with a Knowledge Base for Reasoning in Uncertain Conditions. Biologically Inspired Cognitive Architectures 2015 (Submitted)

Answering Queries with Displacer
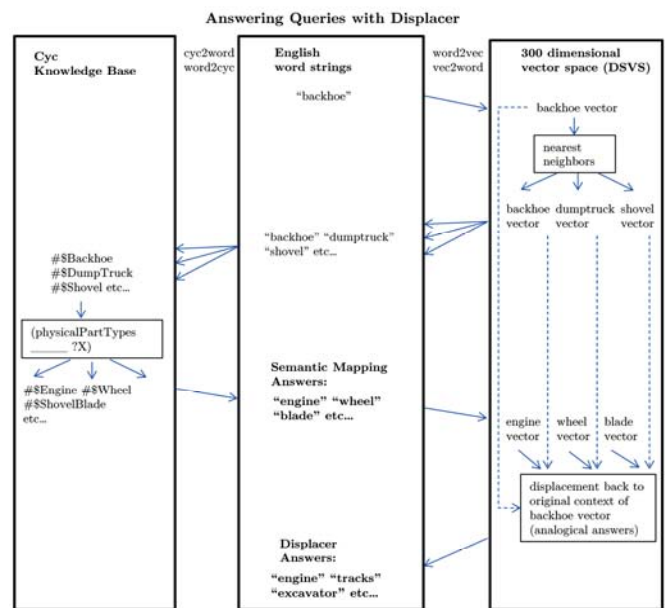
Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Expertise in knowledge bases, machine learning, semantic vector spaces, and natural language processing
- We are working with researchers from Va. Tech, USC, and the Robotics CTA partners at CMU and GDRS to add knowledge to the system via sensors and language and be able to ask questions and give orders in English.